

PATENT ABSTRACTS OF JAPAN

BS

(11)Publication number : 2000-258438

(43)Date of publication of application : 22.09.2000

(51)Int.Cl.

G01N 35/10

B01J 4/02

B01L 3/02

G01N 1/00

G01N 31/16

(21)Application number : 2000-056122

(71)Applicant : SHIBIO INSTRUMENTS GMBH

(22)Date of filing : 01.03.2000

(72)Inventor : THOMAS MOLE
POBERING SEBASTIAN

(30)Priority

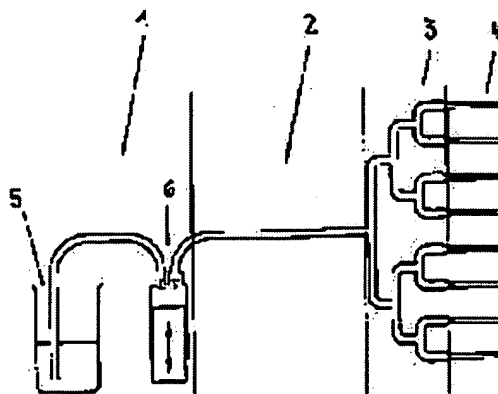
Priority number : 99 19911456 Priority date : 08.03.1999 Priority country : DE

(54) MULTI-CHANNEL DROP GENERATING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To drop high accuracy multi-channel drops by providing a highly precise metering device, an elastic connecting body, a distributor uniformly assigning liquid to a plurality of outflow ports, and outflow ports exactly dropping correct quantity of small drops.

SOLUTION: A metering device 1 is constituted of a supply vessel 5 and a metering apparatus 6 carrying liquid from the supply vessel 5 to a distributor 3 through a connecting body 2, and outflow ports 4 capable of dropping drops are arranged on the outlets of the distributor 3. This liquid quantity can be precisely adjusted, and must be carried at high repeated accuracy. A pressure vessel or a solenoid valve related to a wobbling piston pump can be conveniently utilized. Strong wave motion of the metering device 1 is transmitted to the distributor 3 and the outflow ports 4 through the connecting body 2, and hereat pressure pulse is generated for dropping small drops. Further this distributor 3 brings uniform assignment of pressure pulse from the inlet to the outlet.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the
examiner's decision of rejection or application converted
registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

*** NOTICES ***

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] A multi-channel drop generator or dropping equipment is used for filling the cavity of a micro titration plate especially with a liquid so that it may often be referred to with the conventional technique.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art] These consist of a pump and the distributor connected to it through Rhine generally. The solution known from the conventional technique fills a cavity with the difference of the smallest possible capacity, i.e., it aims at the liquid of this capacity always being dropped in all the tap holes of a distributor.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In order to attain this purpose, various solution about the design of a distributor is developed especially. This distributor is often designed as a tubular distributor. However, this bars equal distribution correctly for this principle of operation.

[0004] As for this flow, it is more desirable than the tap hole which is in whether you are Haruka in the distance to pass through the tap hole where the distance from the input of a distributor is shorter. U.S. Pat. No. 5,334,352 explains the modification of such a distributor. There, the attempt which compensates the part which narrowed the installation part and the controlled cross section, and improves this inclination is made. However, the property of those liquids and adjustment which should be distributed are taken and this kind of arrangement configuration can be used only in the range limited to other liquids. Dropping of $V < 10\text{micro}$ of globules 1 is possible at this disposition, only when the liquid which should be dropped contacts other front faces, otherwise, this drop does not separate from a tap hole for that surface tension.

[0005] Dropping equipment equipped with other deformation of a distributor is EP. 0 180 591 It is well-known B1. It consists of a level distribution tube fundamentally, at least two packed tubes go caudad behind a deflection field toward the upper part next first from the distribution tube, and this reaches an outflow field. In this deflection field, these packed tubes of each other are connected through compensation tubing. In order to compensate the comparatively intense pump wave motion and to pull back the liquid in a packed tube about 1-2mm after termination of each pump actuation, if a spring material constitutes Rhine between a pump and a distributor, it is convenient. The purpose is preventing post-dropping certainly. It is because this dropping equipment is not suitable for making a large number dropping of the amount of isochore of about 0.5-10microl perform to coincidence, because even a slightly different liquid column head in the outflow field of a packed tube serves as dropping capacity which is different during measuring [degree] actuation in each tap hole after a liquid is pulled back.

[0006] Other distributor structures are common knowledge from the printing technique for applying printing ink for example, to a printing roller at the thickness of homogeneity. the arrangement configuration from U.S. Pat. No. 5,441,204 -- a line -- in order to attain the homogeneity distribution in a tap hole, the hyperfractionation of a liquid flow is used. It is possible to attain division of the input liquid flow in which each tap hole comes to have the flow of this capacity regardless of the fluid characteristic of the distributed liquid by this principle. Dropping of a drop is performed by the electrostatic principle, and the liquid continuously carried by it is charged electrostatic and separated from the front face by electric field. Although this kind of distributor cannot be said to be possible practical always, it can be used only within the arrangement configuration which has the demarcated electric field.

[0007] Even if the purpose used as the base of this invention does not make it charged electrostatic although a liquid is dropped through two or more tap holes of tales doses in the capacitor range of about 0.5-10microl, it is offering a suitable multi-channel drop generator.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] It is substantially attained by a multi-channel drop generator being designed fundamentally and operating so that it may happen through the tap hole which is another side, without dropping of this purpose being one side, and contacting others, and is deterministically emptied completely after each dropping actuation to capacity dropping precision.

[0009] This invention is explained in full detail below by the instantiation target mode, while referring to drawing.

[0010]

[Embodiment of the Invention] The multi-channel drop generator by this invention consists of the following component shown in drawing 1. It is attached in the outlet of the distributor 3 which assigns the metering installation 1 which carries the liquid of the capacity which can be adjusted to a precision, the connection object 2 of the demarcated resiliency which combines a metering installation with a distributor, and the liquid of the supplied amount to homogeneity in two or more tap holes, and a distributor, and consists of the tap hole 4 which can trickle a very small drop according to those design structures.

[0011] A metering installation (or **** equipment) 1 consists of the supply container 5 and the measuring instrument 6 which carries a liquid to a distributor 3 through the connection object 2 from the supply container 5, and the tap hole 4 which makes it possible to drop a drop is arranged at the outlet of a distributor. Moreover, this volume must be carried in a repetitive high precision so that it can adjust to a precision. The solenoid valve relevant to a pressurized container or a WOBU ring piston pump can be used with sufficient convenience. The strong wave motion of a metering installation 1 is transmitted to a distributor 3 and a tap hole 4 through the connection object 2, and generates the pressure pulse which enables it to drop a globule there.

[0012] the resiliency demarcated in order that this connection object might reduce the steep slope of the edge of a pressure pulse -- desirable -- a hose-like component -- it is.

[0013] As shown in drawing 1 and drawing 2, ***** 3 is a flat-surface channel system which consists of pieces of like [**** T] equipped with one inlet port 12 and two or more outlets 13, and can process said system for example, into a tabular ingredient. This kind of structure ensures distribution uniform to the accuracy of a liquid which passes through an outlet regardless of a fluid-property while stopping the useless volume to the minimum. Furthermore, this distributor 3 brings about uniform assignment of the pressure pulse from an inlet port to an outlet. Since the channel cross section of this channel system is large compared with a tap hole 4, there is so little effect of the dynamic trait of a multi-channel drop generator exerted on a distributor 3 that it can be disregarded.

[0014] The tap hole 4 which constitutes the part to which the cross section is thin, therefore forms high flow resistance in a multi-channel drop generator is arranged at an outlet. In the case of for example, precision tubing, those tap holes must have an advanced manufacture precision realized so that a tap hole 4 can form the fluid resistance of tales doses. Therefore, the manufacture tolerance in a channel system is compensated. Furthermore, the liquid column in a tap hole 4 has the highest inertia within [all] a system, therefore has the considerable effect of dynamic effect on all systems. In order to understand a multi-channel drop generator about dropping of a very small drop especially, in addition to considering a static parameter, it is also necessary to consider dynamics, but this will be made using an equivalence electrical diagram. Drawing 1 happens the equivalence electrical diagram (drawing 3) reducible to the simplified equivalence electrical diagram (drawing 4) explained in full detail. This constitutes the series resonant circuit essentially equipped with the power excitation which can be explained with the differential equation from electric engineering. A metering installation 1 is imitated by the power source 7 equipped with the switch 8, and a further

elastic connection object is imitated by the capacitor 9. A distributor is disregarded. A tap hole is shown as a resistor 10 and the inertia section 11.

[0015] When a multi-channel drop generator is considered in the semi-static condition and a liquid is gently added by the metering installation 1, a drop is formed in a tap hole 4, and when the weight of the drop exceeds the surface tension, it separates. The so-called meniscus continues, and it remains in a tap hole 4 behind, and becomes incorrectness. Thus, since the generated drop has the capacity of about 10-20microl in the case of water, it does not suit the set-up target.

[0016] Therefore, the description indispensable to this invention from which a metering installation 1 carries the capacity which should be dropped to a tap hole 4 by the high bearer rate through the connection object 2 and a distributor 3 is followed. The liquid exhaust nozzle which has the diameter of a tap hole 4 is formed there. Inertia prevents drop formation. When the liquid flow is interrupted suddenly, before a drop is obtained for high kinetic energy, the jet separates. However, an undecided quantity of a liquid remains in the tap hole 4, and forms a meniscus also here. This liquid must be removed so that it may not have a bad influence on the result of the following dropping cycle. Although it may be carried out by operating a metering installation 1 conversely, since this is high-speed, it will follow increase of technical expenses on this greatly. In the multi-channel drop generator by this invention, in the case of initiation of the dropping cycle which this purpose is designed as elastic components and attained with the connection object 2 which can achieve this function, this connection object 2 is that cross-section expansion, it absorbs a part of conveyed capacity, advances further, and emits it partially again. When the capacity style is barred, the inertia of the liquid column in a tap hole 4 carries out short continuation of the movement of a capacity style. This flow capacity is distributed by the resiliency of the connection object 2, and a vacuum is generated. If this liquid column stops, as for this vacuum, that residual liquid object will be returned from a tap hole 4.

[0017] Under the reserve conditions of a prior compensation pressure ratio, a metering installation 1 begins to carry a capacity style in the time amount $t=0$ by which the sequence (the capacity style from which VA produced the capacity style which was shown in drawing 5, and in which VD was generated by the metering installation 1 here in the tap hole is shown) of a measuring cycle with the passage of time is established as follows.

[0018] This causes the pressure buildup which cannot flow out at first, therefore leads to expansion of the volume of the elastic connection object 2 for the inertia in a tap hole 4. The liquid column in a tap hole 4 is accelerated, and a capacity style is formed into it. The pressure within the connection object 2 descends to the level decided by fluid resistance and the fluid which passes along it, and a part of stored capacity is emitted. This is equivalent to a semi-static condition.

[0019] If the supplied capacity style is interrupted in time amount $t=1$, continuation of the capacity style sent from supply of the capacity stored in the connection object 2 will take place until contraction of capacity takes place there in relation to the vacuum with which the inertia severs a capacity style at first. This vacuum will be maintained within the connection object 2, if a capacity style stops. The direction of a capacity style goes back by it, and the liquid is returned in a distributor from a tap hole 4. The residual liquid in those tap holes is removed.

[0020] This behavior of the capacity style VA in a tap hole is based on adjustment of a fluid resonance circuit.

[Translation done.]

*** NOTICES ***

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The outline design structure of a multi-channel drop generator is shown.

[Drawing 2] Two sectional views of the design structure of the distributor equipped with the tap hole are shown.

[Drawing 3] The detailed equivalence electrical diagram of a multi-channel drop generator is shown.

[Drawing 4] The equivalence electrical diagram which the multi-channel drop generator simplified is shown.

[Drawing 5] The curve showing the property of the capacity style trickled by the metering installation and the tap hole is shown.

[Description of Notations]

- 1 Metering Installation
- 2 Resiliency Connection Object
- 3 Distributor
- 4 Solenoidal Stream Outlet
- 12 Inlet Port
- 13 Outlet

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] A multi-channel drop generator or dropping equipment is used for filling the cavity of a micro titration plate especially with a liquid so that it may often be referred to with the conventional technique.

[0002]

[Description of the Prior Art] These consist of a pump and the distributor connected to it through Rhine generally. The solution known from the conventional technique fills a cavity with the difference of the smallest possible capacity, i.e., it aims at the liquid of this capacity always being dropped in all the tap holes of a distributor.

[0003]

[Problem(s) to be Solved by the Invention] In order to attain this purpose, various solution about the design of a distributor is developed especially. This distributor is often designed as a tubular distributor. However, this bars equal distribution correctly for this principle of operation.

[0004] As for this flow, it is more desirable than the tap hole which is in whether you are Haruka in the distance to pass through the tap hole where the distance from the input of a distributor is shorter. U.S. Pat. No. 5,334,352 explains the modification of such a distributor. There, the attempt which compensates the part which narrowed the installation part and the controlled cross section, and improves this inclination is made. However, the property of those liquids and adjustment which should be distributed are taken and this kind of arrangement configuration can be used only in the range limited to other liquids. Dropping of $V < 10$ micro of globules is possible at this disposition, only when the liquid which should be dropped contacts other front faces, otherwise, this drop does not separate from a tap hole for that surface tension.

[0005] Dropping equipment equipped with other deformation of a distributor is EP. 0 180 591 It is well-known B1. It consists of a level distribution tube fundamentally, at least two packed tubes go caudad behind a deflection field toward the upper part next first from the distribution tube, and this reaches an outflow field. In this deflection field, these packed tubes of each other are connected through compensation tubing. In order to compensate the comparatively intense pump wave motion and to pull back the liquid in a packed tube about 1-2mm after termination of each pump actuation, if a spring material constitutes Rhine between a pump and a distributor, it is convenient. The purpose is preventing post-dropping certainly. It is because this dropping equipment is not suitable for making a large number dropping of the amount of isochore of about 0.5-10microl perform to coincidence, because even a slightly different liquid column head in the outflow field of a packed tube serves as dropping capacity which is different during measuring [degree] actuation in each tap hole after a liquid is pulled back.

[0006] Other distributor structures are common knowledge from the printing technique for applying printing ink for example, to a printing roller at the thickness of homogeneity. the arrangement configuration from U.S. Pat. No. 5,441,204 -- a line -- in order to attain the homogeneity distribution in a tap hole, the hyperfractionation of a liquid flow is used. It is possible to attain division of the input liquid flow in which each tap hole comes to have the flow of this capacity regardless of the fluid characteristic of the distributed liquid by this principle. Dropping of a drop is performed by the electrostatic principle, and the liquid continuously carried by it is charged electrostatic and separated from the front face by electric field. Although this kind of distributor cannot be said to be possible practical always, it can be used only within the arrangement configuration which has the demarcated electric field.

[0007] Even if the purpose used as the base of this invention does not make it charged electrostatic although a liquid is

dropped through two or more tap holes of tales doses in the capacitor range of about 0.5-10microl, it is offering a suitable multi-channel drop generator.

[0008]

[Means for Solving the Problem] It is substantially attained by a multi-channel drop generator being designed fundamentally and operating so that it may happen through the tap hole which is another side, without dropping of this purpose being one side, and contacting others, and is deterministically emptied completely after each dropping actuation to capacity dropping precision.

[0009] This invention is explained in full detail below by the instantiation target mode, while referring to drawing.

[0010]

[Embodiment of the Invention] The multi-channel drop generator by this invention consists of the following component shown in drawing 1 . It is attached in the outlet of the distributor 3 which assigns the metering installation 1 which carries the liquid of the capacity which can be adjusted to a precision, the connection object 2 of the demarcated resiliency which combines a metering installation with a distributor, and the liquid of the supplied amount to homogeneity in two or more tap holes, and a distributor, and consists of the tap hole 4 which can trickle a very small drop according to those design structures.

[0011] A metering installation (or **** equipment) 1 consists of the supply container 5 and the measuring instrument 6 which carries a liquid to a distributor 3 through the connection object 2 from the supply container 5, and the tap hole 4 which makes it possible to drop a drop is arranged at the outlet of a distributor. Moreover, this volume must be carried in a repetitive high precision so that it can adjust to a precision. The solenoid valve relevant to a pressurized container or a WOBU ring piston pump can be used with sufficient convenience. The strong wave motion of a metering installation 1 is transmitted to a distributor 3 and a tap hole 4 through the connection object 2, and generates the pressure pulse which enables it to drop a globule there.

[0012] the resiliency demarcated in order that this connection object might reduce the steep slope of the edge of a pressure pulse -- desirable -- a hose-like component -- it is .

[0013] As shown in drawing 1 and drawing 2 , ***** 3 is a flat-surface channel system which consists of pieces of like [**** T] equipped with one inlet port 12 and two or more outlets 13, and can process said system for example, into a tabular ingredient. This kind of structure ensures distribution uniform to the accuracy of a liquid which passes through an outlet regardless of a fluid-property while stopping the useless volume to the minimum. Furthermore, this distributor 3 brings about uniform assignment of the pressure pulse from an inlet port to an outlet. Since the channel cross section of this channel system is large compared with a tap hole 4, there is so little effect of the dynamic trait of a multi-channel drop generator exerted on a distributor 3 that it can be disregarded.

[0014] The tap hole 4 which constitutes the part to which the cross section is thin, therefore forms high flow resistance in a multi-channel drop generator is arranged at an outlet. In the case of for example, precision tubing, those tap holes must have an advanced manufacture precision realized so that a tap hole 4 can form the fluid resistance of tales doses. Therefore, the manufacture tolerance in a channel system is compensated. Furthermore, the liquid column in a tap hole 4 has the highest inertia within [all] a system, therefore has the considerable effect of dynamic effect on all systems. In order to understand a multi-channel drop generator about dropping of a very small drop especially, in addition to considering a static parameter, it is also necessary to consider dynamics, but this will be made using an equivalence electrical diagram. Drawing 1 happens the equivalence electrical diagram (drawing 3) reducible to the simplified equivalence electrical diagram (drawing 4) explained in full detail. This constitutes the series resonant circuit essentially equipped with the power excitation which can be explained with the differential equation from electric engineering. A metering installation 1 is imitated by the power source 7 equipped with the switch 8, and a further elastic connection object is imitated by the capacitor 9. A distributor is disregarded. A tap hole is shown as a resistor 10 and the inertia section 11.

[0015] When a multi-channel drop generator is considered in the semi- static condition and a liquid is gently added by the metering installation 1, a drop is formed in a tap hole 4, and when the weight of the drop exceeds the surface tension, it separates. The so-called meniscus continues, and it remains in a tap hole 4 behind, and becomes incorrectness. Thus, since the generated drop has the capacity of about 10-20microl in the case of water, it does not suit the set-up target.

[0016] Therefore, the description indispensable to this invention from which a metering installation 1 carries the capacity which should be dropped to a tap hole 4 by the high bearer rate through the connection object 2 and a

distributor 3 is followed. The liquid exhaust nozzle which has the diameter of a tap hole 4 is formed there. Inertia prevents drop formation. When the liquid flow is interrupted suddenly, before a drop is obtained for high kinetic energy, the jet separates. However, an undecided quantity of a liquid remains in the tap hole 4, and forms a meniscus also here. This liquid must be removed so that it may not have a bad influence on the result of the following dropping cycle. Although it may be carried out by operating a metering installation 1 conversely, since this is high-speed, it will follow increase of technical expenses on this greatly. In the multi-channel drop generator by this invention, in the case of initiation of the dropping cycle which this purpose is designed as elastic components and attained with the connection object 2 which can achieve this function, this connection object 2 is that cross-section expansion, it absorbs a part of conveyed capacity, advances further, and emits it partially again. When the capacity style is barred, the inertia of the liquid column in a tap hole 4 carries out short continuation of the movement of a capacity style. This flow capacity is distributed by the resiliency of the connection object 2, and a vacuum is generated. If this liquid column stops, as for this vacuum, that residual liquid object will be returned from a tap hole 4.

[0017] Under the reserve conditions of a prior compensation pressure ratio, a metering installation 1 begins to carry a capacity style in the time amount $t = 0$ by which the sequence (the capacity style from which VA produced the capacity style which was shown in drawing 5, and in which VD was generated by the metering installation 1 here in the tap hole is shown) of a measuring cycle with the passage of time is established as follows.

[0018] This causes the pressure buildup which cannot flow out at first, therefore leads to expansion of the volume of the elastic connection object 2 for the inertia in a tap hole 4. The liquid column in a tap hole 4 is accelerated, and a capacity style is formed into it. The pressure within the connection object 2 descends to the level decided by fluid resistance and the fluid which passes along it, and a part of stored capacity is emitted. This is equivalent to a semi-static condition.

[0019] If the supplied capacity style is interrupted in time amount $t = 1$, continuation of the capacity style sent from supply of the capacity stored in the connection object 2 will take place until contraction of capacity takes place there in relation to the vacuum with which the inertia severs a capacity style at first. This vacuum will be maintained within the connection object 2, if a capacity style stops. The direction of a capacity style goes back by it, and the liquid is returned in a distributor from a tap hole 4. The residual liquid in those tap holes is removed.

[0020] This behavior of the capacity style VA in a tap hole is based on adjustment of a fluid resonance circuit.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] A metering installation (1) and the distributor which has one inlet port (12) and two or more outlets (13) (3), So that it may be the multi-channel drop generator equipped with the resiliency connection object (2) by which said metering installation (1) is connected to said inlet port (12) through it and a pressure may be divided into homogeneity for said inlet port (12) It connects with said outlet (13) through the flat-surface channel system which consisted of pieces of-like [**** T]. The resiliency of the connection object (2) with which there is a solenoidal stream outlet (4) in said outlet (13), the cross section is smaller than the cross section of the channel in said distributor (3), and resiliency has the die length and cross section, die length, and a cross section, The multi-channel drop generator which has dynamic effect, therefore serves as non-contact liquid dropping, and can empty said tap hole (4) completely continuously since it is adjusted with the bearer rate of said metering installation (1).

[Translation done.]

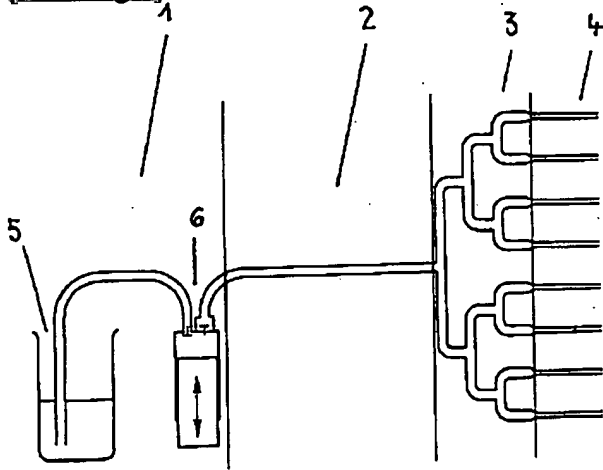
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

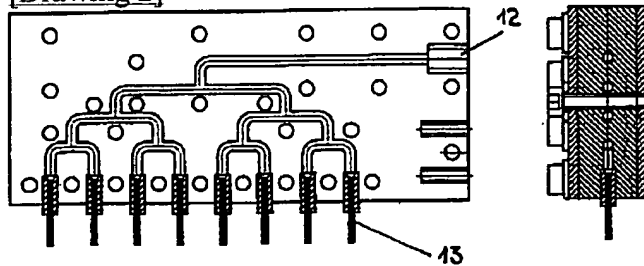
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

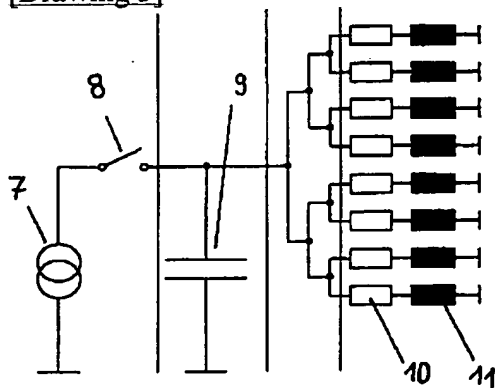
[Drawing 1]



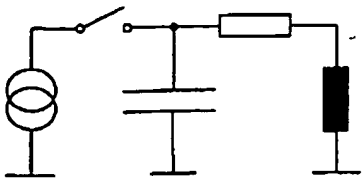
[Drawing 2]



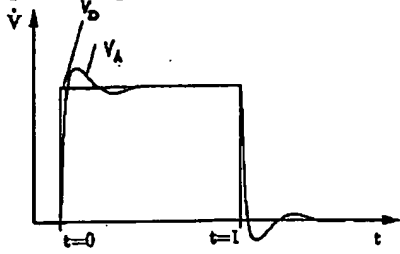
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]